Total sulfur determination in liquid fuels by ICP-OES after oxidation-extraction desulfurization using magnetic graphene oxide†

Mazaher Ahmadi[a,*], Miguel Ángel Aguirre[b], Tayyebeh Madrakian[a], Abbas Afkhami[a], Antonio Canals[b,*]

[a]*Faculty of Chemistry, Bu-Ali Sina University, Hamedan, Iran.*

[b] *Department of Analytical Chemistry and Food Science and University Institute of Materials, Faculty of Science, University of Alicante, P.O. Box 99 - 03080 Alicante, Spain.*

[*] *Corresponding authors emails: m.ahmadi@basu.ac.ir (M. Ahmadi), a.canals@ua.es (A. Canals)*

†Electronic supplementary information (ESI) available.

Table S1. Instrumental conditions for ICP-OES measurements.

Parameter	Value
RF generator power (kW)	1.2
Plasma gas flow rate (L min^{-1})	15
Auxiliary gas flow rate (L min^{-1})	1.5
Nebulizer type	OneNeb®
Spray chamber type	Cyclonic
Nebulizer gas flow rate (L min^{-1})	0.75
Sample flow rate (µL min^{-1})	450
View mode	Axial
Read time (s)	3
Replicates	3
Analytical lines (nm)	S I (181.972)

Table S2. Experimental factors and levels of the Plackett-Burman design for the sorption step.

Factor	Level	
	Low (-1)	High (+1)
HNO_3 volume (µL, 60% w w^{-1})	5	50
H_2O_2 volume (µL, 30% w w^{-1})	500	1000
Sorption time (min)	10	60
MGO amount (mg)	5	20

Table S3. Factors, low and high levels, central and star points used in the CCCD design for the sorption step.

Factor	Level			Star points (α=1.4142)	
	Low (-1)	Central (0)	High (+1)	-α	+α
Sorption time (min)	14	33	52	6	60
MGO amount (mg)	8	13	18	6	20

Table S4. Factors, low and high levels, central and star points used in the CCCD design for the desorption step.

Factor	Level			Star points (α=1.4142)	
	Low (-1)	Central (0)	High (+1)	-α	+α
Desorption time (min)	2.3	5.5	8.7	1	10
Methanol volume (µL)	232	550	868	100	1000

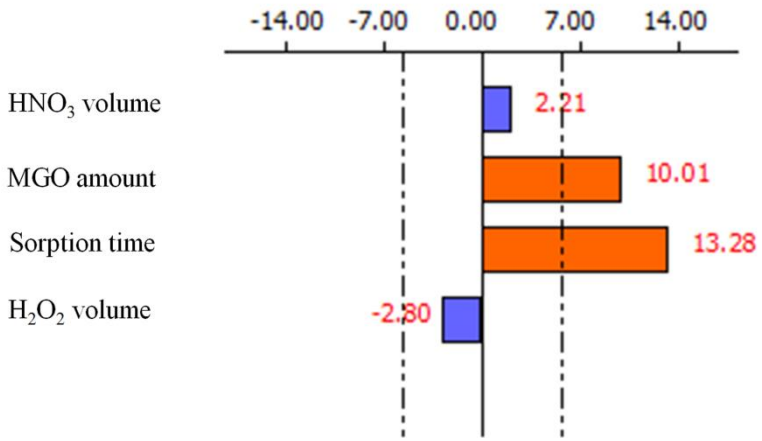

Fig. S1. Pareto charts of the main effects obtained from Plackett-Burman design for the sorption step.

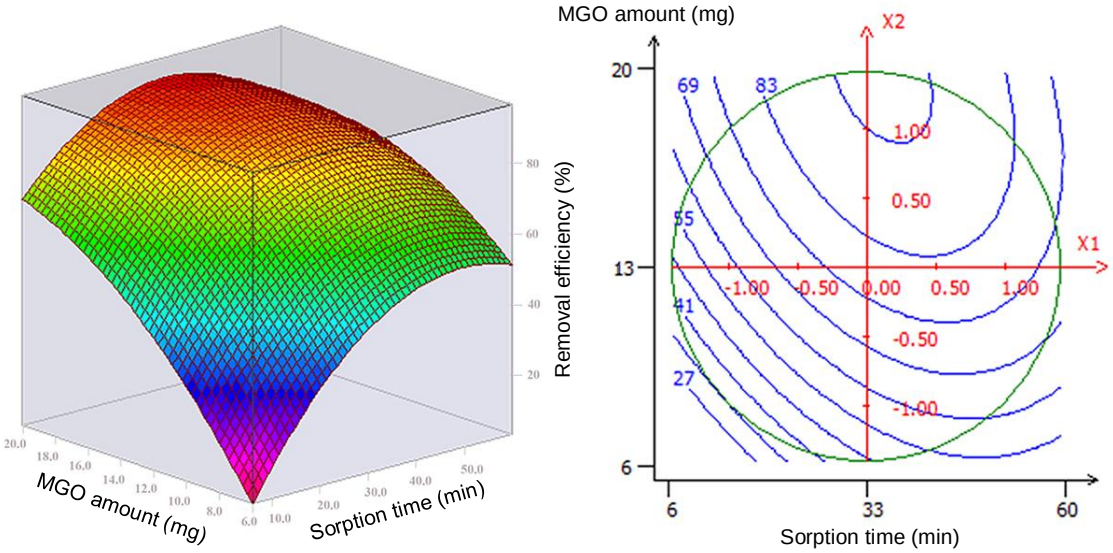

Fig. S2. Response surface and contour plot of the CCCD design and the corresponding contour plot obtained by plotting MGO amount versus sorption time for the sorption step.

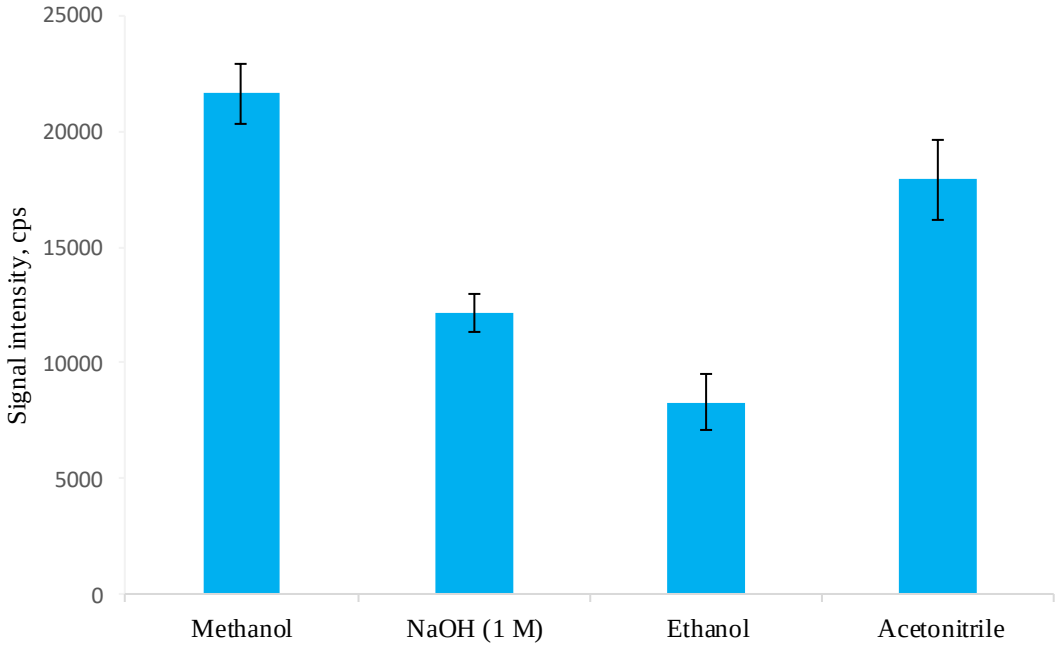

Fig. S3. Effect of different eluents on desorption of the adsorbed oxidized-sulfur compounds (n=3). Sorption conditions: MGO amount, 20 mg; sorption time, 33 min; and HNO_3 and H_2O_2 volumes, 50 and 500 µL, respectively. Desorption conditions: eluent volume, 1.0 mL; and desorption time, 10 min.

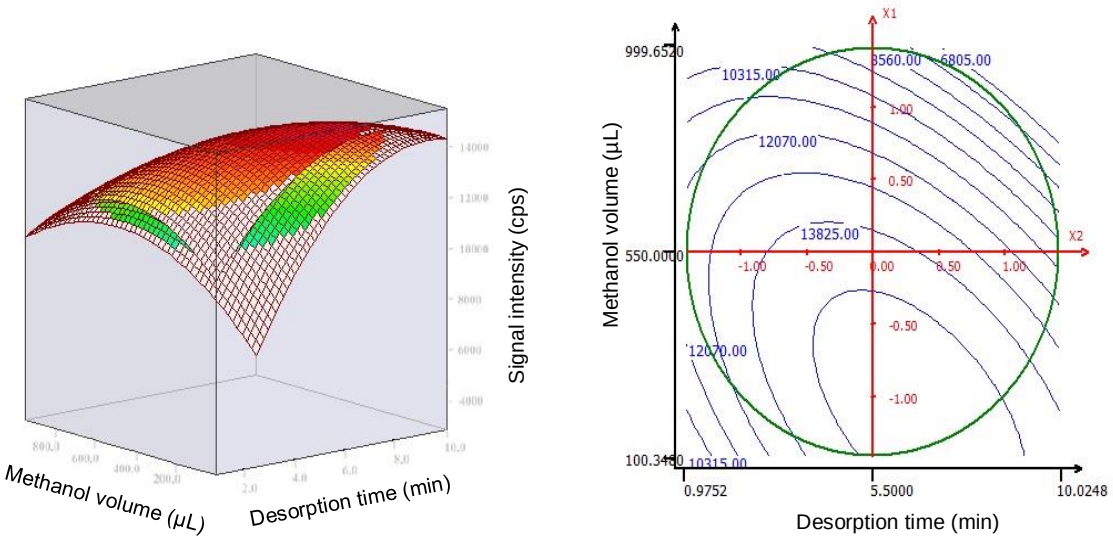

Fig. S4. Response surface and contour plot of the CCCD design and the corresponding contour plot obtained by plotting methanol volume versus desorption time for the desorption step.